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THE EFFECTS OF COGNITIVE LOAD CONDITIONS UPON PERFORMANCE, ANXIETY, AND SELF-EFFICACY IN COMPUTER BASED LEARNING ENVIRONMENTS

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THE EFFECTS OF COGNITIVE LOAD CONDITIONS UPON PERFORMANCE, ANIXETY, AND SELF-EFFICACY IN COMPUTER BASED LEARNING ENVIRONMENTS

A Dissertation APPROVED FOR THE

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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ABSTRACT

The present study examined whether an extraneous cognitive load condition adversely affected participants' performance, self-efficacy, and anxiety. The participants were sixty-six pre-service teacher education students across two pre-service undergraduate teacher education courses who volunteered to take part in this study. The correlation coefficient was used for the content because Nolen (1995) found that self-efficacy for statistics was related to cognitive engagement. Participants were randomly assigned to either an extraneous cognitive load or non-extraneous cognitive load condition.

This study yielded a mixture of significant and non-significant findings regarding the effect of extraneous cognitive load upon motivation and performance. The results suggest two things. First, the correlation instruction improved participants' self-efficacy. Second, that there were confounds such as processing time and content domain that may have affected the results. This suggests that extraneous cognitive load conditions can still adversely impact motivation and performance, but further research is needed to examine these issues.

CHAPTER 1

Introduction and Literature Review

Introduction

One of the important issues facing instructional designers is how to develop instruction that effectively helps learners construct the knowledge they need without overloading their cognitive processing capabilities. Research on the detrimental effects of such overloading of the cognitive system has been conducted under the name of cognitive load (Mayer and Anderson, 1991; Mayer and Moreno, 1998; Mayer, Moreno, Boire, and Vagge, 1999; Moreno and Mayer, 1999; Mousavi, Low, and Sweller, 1995). Although research in this area has revealed a number of important instructional design factors that negatively affect cognitive load and undermine learning, questions have recently arisen regarding the role learner motivation might play in the process (Paas, 1992; Pass, Renkl, and Sweller, 2003). The purpose of the study I conducted was to investigate the impact that different cognitive load conditions might have on learner anxiety, self-efficacy, and performance. (Bandura, 1986; 1997; Mayer and Moreno, 2003). Before presenting the specific aims of my research I would first like to review the extant literature to provide the context for the study.

This literature review will focus on three areas. First, I will outline and explain the theoretical constructs of cognitive load and working memory in the context of the cognitive theory of multimedia learning proposed by Mayer and Moreno (2003). In doing so, I will define and draw a relationship between motivation and performance. I will also examine the relevant literature pertaining to extraneous cognitive load and self-efficacy literature as related to performance. At the conclusion of the literature review, I will synthesize the findings of the literature and describe the research questions guiding my study of cognitive load and motivation.

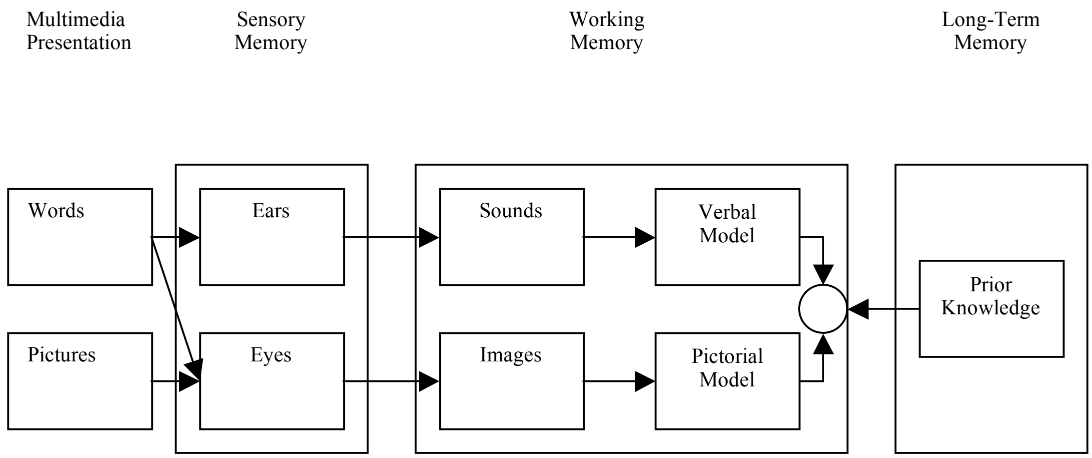
Theoretical Constructs

In this section, I will outline how working memory operates within the cognitive theory of multimedia learning and the learning problems that can occur in working memory; I will explain what cognitive load is and how it is related to working memory; and finally, I will outline the components of motivation and how motivation is related to performance.

Cognitive Theory of Multimedia Learning

When designing instruction, it is important to understand the learning process as outlined in the cognitive theory of multimedia learning (Mayer and Moreno, 2003). The first component in the cognitive theory of multimedia learning (see Figure 1) is the sensory memory. Sensory memory is a mechanism that holds many pieces of information very briefly so that we can decide whether to select or dismiss the information (Baddeley, 1986; Mayer and Moreno, 2003). In the cognitive theory of multimedia learning, there are sensory memories for sights (eyes) and sounds (ears). The sensory memories for ears and eyes are very large and contain more information than learners could possibly handle. The sensory memories duration are fragile, and a learner can only retain information in their sensory memories for one to three seconds. For example, people might be learning how to bake an apple pie using a multimedia program. Those individuals can attend to words with their eyes or ears dependent upon whether the multimedia program presents the information as text or narration. These same individuals can choose to attend to an animation or picture with their eyes. However, the attention the individual has on learning how to bake an apple pie comes with a price. It will lead him or her to forget about a side conversation occurring in the room where the learning to bake an apple pie takes place.

Figure 1



Source: Mayer and Moreno (2003)

Once individuals have decided to focus upon some information in the multimedia program, they have moved the information into working memory via visual and verbal channels (Baddeley, 1986; Mayer and Moreno, 2003). Learners have several options to retain the information since working memory has a very limited capacity (approximately 5-9 items) according to Baddeley (1986). First, learners can repeat or rehearse the information to maintain it in working memory. Second learners can integrate the information with other information with other information previously saved so they can remember and recall the information later.

Mayer and Moreno (2003) define the working memory channels as verbal (sounds) and pictorial (images) models. Each channel processes information separately and integrates the information with previously existing schema to construct more elaborative or a new schema. For example, if a learner is examining images that show how lightning occurs, the learner uses previously existing schemas to process, organize, and pair the new information about thunder with related topics. If narration is added, the learner uses previously existing schemas to process, organize, and pair the new verbal information about thunder with related topics. In addition, it is possible for the verbal and pictorial models within working memory to work in concert to allow a referential connection to occur between the narrative and image descriptions of how thunder occurs. The learner pairs the enriched information with previously existing schemas to construct more elaborative or a new schema. Regardless of whether the two working memory channels are working independently or together, the newly integrated information is then represented or stored in the limitless capacity of long-term memory (Anderson, 2000; Baddeley, 1986).

Cognitive Load

Cognitive load is a theory directly related to working memory and information processing. Cognitive load theory explains the limitations of working memory and its relationship to the mental load of a task and how instructional design can impact cognitive load. Below I review how cognitive load influences the processing of information?

There are three types of cognitive load that influence the processing of information. Those are intrinsic, germane, and extraneous cognitive load. I will define and explain how each type of cognitive load influences instruction.

Intrinsic Cognitive Load.

Paas, Renkl and Sweller (2003) define intrinsic cognitive load as "…demands on working memory capacity imposed by element interactivity [that] are intrinsic to the material being learned" (p.1). Element interactivity refers to elements of a task and whether each element could be understood and learned individually without consideration of the other elements. Paas, Renkl, and Sweller (2003); Kirschner (2002); and Sweller (1994) agree that the instructional designer cannot alter or manipulate instruction to control intrinsic cognitive load due to the element interactivity of the task. Paas, Renkl, and Sweller contend that any attempt to instructionally manipulate instruction does not assist learning but compromises the sophisticated understanding of very complex, high-element interactivity tasks. For example, an instructional designer could attempt to take a calculation out of a correlation lesson due to its complexity, but the omission of the procedure will compromise the instruction. If the instructional goal was to learn how to mathematically generate a correlation, then the learner will not have the knowledge necessary to mathematically generate a correlation. As Pass, Renkl, and Sweller noted, "Simultaneous processing of all essential elements must occur eventually despite the high-intrinsic cognitive load because it is only then that understanding commences" (p. 1).

Germane Cognitive Load.

Although the instructional designer cannot manipulate intrinsic cognitive load, the instructional designer can control germane and extraneous cognitive load. Germane cognitive load refers to instructional manipulations that assist the learner to use working memory resources to learn a specific activity or task. Instruction could include materials that were learned previously that would assist the learner in schema acquisition and automation. For example, an instructional designer could develop instruction covering how to throw a football and reference the learner's previous knowledge of throwing a baseball and drawing a parallel to the two in terms of the position of one's feet while throwing a football and baseball. The link between the two items will most likely assist the learner with schema acquisition and automation.

Extraneous cognitive load.

Another type of cognitive load, which the instructional designer can manipulate, is extraneous cognitive load. Extraneous cognitive load refers to working memory resources being devoted to elements of instruction that are unnecessary and interfere with schema activation and automation (Paas, Renkl, and Sweller, 2003). For example, if the directions for assembling a bicycle outline the assembly steps on one page, but put the diagrams on separate pages, this can impair schema activation and automation because the learners must spend working memory capacity to search for the diagrams and make referential connections back to the text instructions.

There are several questions arising out of the previous discussion. Which design features lead to extraneous cognitive load? Does the inclusion of these features in instruction inhibit performance? If the inclusion of the features leads to reduced performance, then is the inhibited performance due to reasons consistent with the information-processing model and working memory theory? In the review of the literature on design factors influencing cognitive load, I will address these questions and synthesize the findings.

Design Factors Influencing Cognitive Load

This portion of the literature review will focus on the instructional design implications of cognitive load in the context of multimedia learning. Existing research has examined the impacts of multimedia instruction designed to create extraneous cognitive load, for example, using words as text rather than narration, separating animation and narration, and presenting too much information at one time. In reviewing the research, I will define each concept; outline the results, and the theoretical and practical implications on learning that result when extraneous cognitive load is created.

Modality Principle.

One component of the cognitive load issue is the modality principle. The modality principle refers to the learner needing to shift attention between two simultaneous presentations of visual stimuli in order to process both stimuli (Penney, 1989; Moreno and Mayer, 1999; Sweller, 1999). When such simultaneous visual presentations occur, the learner does not have enough working memory capacity in the visual working memory channel to process both. As a result, encoding is unable to occur.

An example of research dealing with the modality principle is Mayer and Moreno (1998). In this study, they had two treatment conditions, animations and textual presentation of verbal information presented concurrently, and animation and narration of the same verbal information presented concurrently. Mayer and Moreno (1998) asked whether participants assigned to the animation and text condition would score significantly lower on retention, matching, and transfer tests than participants assigned to the animation and narration condition. They found that participants in the animation and text group scored significantly lower than participants in the animation and narration group in all three tests in two separate experiments. The findings are consistent with other research (Mousavi, Low, and Sweller, 1995; Moreno and Mayer, 1999) and with the working memory theory proposed by Baddeley (1986). The participants in the animation and text condition encountered extraneous cognitive load because of a bottleneck in their visual working memory that led to decreased capacity to encode and process the animation and textual information simultaneously, which lead to significantly lower scores as compared to participants in the animation and narration condition.

Contiguity Principle.

The contiguity principle is another important aspect to consider while designing instruction. The contiguity principle is also referred to as split-attention effect in the cognitive load literature. There are two types of contiguity effects, spatial-contiguity and temporal-contiguity effects. The spatial-contiguity effect refers to printed text and pictures being physically integrated or in close proximity to one another, while temporal-contiguity refers to the simultaneous presentation of visual and spoken materials (Moreno and Mayer, 1999). Learners presented with the simultaneous visual images and spoken materials should perform significantly better than learners exposed to visual images and spoken materials presented separately. This portion of the review will examine whether the physical separation of words and pictures and visual and spoken materials will lead to impaired performance.

In 1999, Moreno and Mayer explored the issue of whether physically separate pieces of information imposed an extraneous cognitive load upon participants in the separated text (ST – "on-screen text that was separated or physically far from the animation") condition versus participants assigned to the narration (N – concurrent narration and animation) and integrated text (IT – "on-screen text that was integrated or physically close to the animation") conditions as measured by performance on verbal recall, transfer, and matching tests. Moreno and Mayer discovered that the participants in the ST condition scored significantly lower than participants in the N and IT conditions on verbal recall, transfer, and matching tests. These results are consistent with the working memory theory proposed by Baddeley (1986) in two ways. First, the ST participants were required to encode both the animation and text in their visual working memory, which caused a bottleneck in the visual working memory channel. Second, the ST participants were required to use working memory resources to find the text and then relate it to the animation, which may have strained and superceded the participants' working memory capacity.

Another extraneous cognitive load issue is whether the separation of visual images and narration can affect performance. Working memory theory outlines that humans have a very limited capacity in their working memory to encode and process information (Baddeley, 1986). If this is true, then one could hypothesize the following. Learners presented with large bites of separated visual and audio information may face difficulty encoding and processing information compared to those presented with small bites of separated visual and audio information given all other factors are similar.

Mayer, Moreno, Boire, and Vagge (1999) examined this issue in a study that measured whether large bites of separated visual and audio information imposed an extraneous cognitive load upon learners. To measure this, Mayer et al (1999) conducted two separate experiments and randomly assigned participants into three conditions, which were: (1) concurrent presentation of animation and narrated information, (2) presentation of small bites of information (one of a series of 16 segments of animation followed by one of the corresponding segments of narration or vice versa), and (3) presentation of large bites of information (either the entire 16 segment animation track followed by the entire narration track or vice versa). The participants in the large bites condition scored significantly lower in the retention, transfer, and matching tests than in the other two conditions, which did not significantly differ from one another.

These findings are consistent with the working memory theory as proposed by Baddeley (1986). Participants in the large bites condition were exposed to so much information that the participants' working memory capacities were not large enough to allow them to maintain the entire animation or narration in working memory while also attending to either watching the subsequent animation or listening to the subsequent narration. In addition, the participants in the large bites condition faced another obstacle. The presentation of instruction did not allow them to build referential connections between the visual and verbal information. The participants' individual working memories were overtaxed and information in the participants' working memories may have significantly decayed to the point where it was impossible to relate the visual and verbal information to one another.

Summary of design factors influencing cognitive load.

The literature demonstrated that extraneous cognitive load exists, particularly in multimedia instruction. It is apparent that the presentation of animation and text together can impair learners working memories by overloading or creating a bottleneck in their working memories, which leads to impaired performance. In addition, if two related pieces of information are physically separate from one another, it creates an effect where learners' cannot retain information long enough in working memory to associate it with the second related piece of information, which also leads to impaired performance. Therefore, it is important for instructional designers to try to avoid using these design devices in the development of instruction due to the detrimental nature on learners' retention and may adversely influence learners' motivation to learn.

Motivation and Cognitive Load

Although the literature review above indicated that aspects of instructional design can influence the degree of extraneous cognitive load learners face, such design factors are not the only ones potentially influencing extraneous cognitive load. Pass (1992) and Pass, Renkl, and Sweller (2003) noted that motivation is related to cognitive load. It is important to examine motivational theories that are related to learner achievement to answer the following questions. How does motivation affect learner achievement? How is motivation potentially related to cognitive load?

There are several motivational constructs that are related to learner achievement, including intrinsic motivation, achievement goals, and self-efficacy. Intrinsic motivation theory examines the source of motivation and whether motivation lies inside or outside of the individual. According to the literature, individuals intrinsically motivated will pursue tasks on their own initiative, be cognitively engaged in the task, and persist in the face of failure, while those extrinsically motivated learners are less likely to exhibit the previous behaviors (Csikszentmihalyi, 1990; Csikszentmihalyi & Nakamura, 1989; Maehr, 1984). As a result, intrinsically motivated learners achieve at higher levels than extrinsically motivated learners (Lin, McKeachie, & Kim, 2001; Martens, Gulikers, & Bastiaens, 2004).

Achievement goal theory suggests that the motivation to achieve tasks is dependent upon an individual's goal orientation. Midgley et al (2000) outline that there are three achievement goal orientations that guide individuals' goal orientations for performing tasks. Those goal orientations are defined in Table 1.

Table 1

Goal Orientation Definitions

Goal Orientation	Definition
Learning/Mastery	Learner focuses upon developing task competence
Performance-approach	Learner focuses upon demonstrating his or her competence
Performance-avoidance	Learner focuses upon avoiding the demonstration of task incompetence

Miller et al. (1996) study showed that learning/mastery goal orientation that there is a positive relationship between learning/mastery goals and achievement. This relationship is not surprising given that the learners are focused upon the task rather than a reward of recognition or ridicule. Therefore, there are no challenges or threats to learners' self-efficacy, which does not affect the learners' levels of anxiety. Researchers have demonstrated that individuals with a performance approach goal orientation perform better on tasks than those with a performance avoidance orientation (Elliot, 1999; Elliot & Church, 1997). It is plausible to argue that achievement goal theory, in particular performance-avoidance goal orientation, is related to cognitive load through anxiety. Learners are concerned about their lack of competence in the task, which is related to learners' low self-efficacy regarding the task. In turn, the low self-efficacy triggers the elevation of anxiety because learners fear that someone may discover their incompetence. The low self-efficacy and high anxiety generated by the performance-avoidance goal orientated learners consumes working memory space and leaves either little or no room for cognitive processing tasks.

Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute courses of action required to produce a given attainment" (p. 3). He proposed that there is a relationship between self-efficacy and performance. For example, if a student believes he or she can solve a moderately difficult calculus problem, it is a high probability that he or she will successfully solve the calculus problem. Research supporting this claim is reviewed below.

In a correlational study, Pintrich and DeGroot (1990) administered a self-efficacy instrument and collected performance data from 173 seventh-grade students. They found a positive correlation between self-efficacy and performance. These findings are consistent with other correlational research examining the relationship between self-efficacy and performance (Boyce and Bingham, 1997; Elias & Loomis, 2002; Jackson, 2002; Thompson, Meriac, & Cope, 2002). Additionally, there is experimental support for Bandura's (1997) claim that self-efficacy has a causal effect upon performance.

Schunk and Hanson (1985) examined whether modeling influenced the self-efficacy and achievement of 72 eight to ten year old elementary school children, who had difficulty learning subtraction.   They found that students who observed peer models possessed higher self-efficacy and achievement than the students who observed teacher modeling and those receiving no treatment. In addition, Nolen (1995) found that initial self-efficacy for statistics was related to cognitive engagement. The findings are consistent with other experimental research (Schunk 1982-1983; Schunk, 1983; Schunk, 1984; Schunk, 1987) on the effects of self-efficacy on performance.

Of all the motivation factors, self-efficacy may have the greatest likelihood of influencing extraneous cognitive load because Bandura (1986, 1997) proposed that low self-efficacy causes anxiety. Anxiety, the feeling of apprehension and uneasiness about a situation (Goodwin, 1986; Ormrod, 1999), is comprised of two components. One component is physiological, including restlessness or pacing, increased heartbeats, breathing rates, or sweaty palms. The second component is worry, the cognitive aspect of anxiety. Eysenck (1992) asserted that learners with high anxiety devote processing to task-irrelevant information, which leaves fewer working memory resources to process information. For example, an individual taking an exam and having doubts whether he or she can achieve a passing grade (low self-efficacy) might experience anxiety. Anxiety and worry result in thoughts about not doing well and the consequences of failure occupy his or her consciousness. This may leave little to no working memory capacity for the exam itself.

Research has supported Bandura's claim about low self-efficacy causing anxiety (Blair, O'Neil, & Price, 1999; Endler et al, 2001; Malpass, O'Neil, & Hocevar, 1999;

Pajares & Graham, 1999; Pajares & Valiente, 2001). Additionally, research has also supported Eysenck's (1992) claim that anxiety inhibits performance because worry (intrusive thoughts) occupies working memory rather than task-focused thoughts (Borkowski & Mann, 1968; Darke, 1988a; and Darke, 1998b).

Summary of Motivation and Cognitive Load.

This brief review of the literature on motivation and performance has indicated that several aspects of motivation contribute to performance, the intrinsic or extrinsic nature of the motives, the achievement goals individuals pursue, and the self-efficacy of individuals have for the tasks they are performing. Of these motivational perspectives, the one that seems most clearly related to cognitive load is self-efficacy theory.

The self-efficacy and anxiety literature review illustrated that self-efficacy beliefs and anxiety levels are related and can influence performance. It is apparent that self-efficacy can either assist or impair learners' performance. When a learner possesses high self-efficacy, it is advantageous because he or she can use available working memory resources to choose appropriate cognitive strategies to execute tasks necessary to succeed in the activity. On the other hand, when a learner possesses low self-efficacy, it is disadvantageous for several reasons. The learner is using available cognitive resources (available working memory) worrying whether he or she can do the activity. This anxiety can lead to the consumption of most to all cognitive resources. As a consequence, the learner has no cognitive resources available to focus upon using the appropriate cognitive strategies or executing the appropriate skills to succeed in the activity. As a result, the learner with low self-efficacy performs significantly worse than an individual with high self-efficacy. Therefore, it is important for instructional designers to consider self-efficacy type issues while designing instruction to account for self-efficacy, which can play a significant role in performance.

General Summary

It is clear that extraneous cognitive load and low self-efficacy may adversely impact performance. Those exposed to extraneous cognitive load scored significantly lower on measures as compared to participants not exposed to extraneous cognitive load conditions. Self-efficacy also played a role in performance. Those participants with low self-efficacy scored significantly lower as compared to participants with moderate to high levels of self-efficacy. There is a common theme that the extraneous cognitive load and low self-efficacy participants shared. That is both groups used their available working memory to either compensate for poor instructional design or the anxiety related to the activity. As a result, there was limited working memory to use for the development or improvement of cognitive strategies or the appropriate skills related to the activity.

As demonstrated by the research, cognition/instructional design and motivation play an important role in performance. However, further research is needed to examine whether the instructional design elements that have been shown to create extraneous cognitive load also might influence self-efficacy, and whether self-efficacy predicts student anxiety for subsequent performance.

The Present Study

The present study examined whether an extraneous cognitive load condition adversely affected participants' performance, self-efficacy, and anxiety. The participants were sixty-six pre-service teacher education students across two pre-service undergraduate teacher education courses who volunteered to take part in this study. The correlation coefficient was used for the content because Nolen (1995) found that self-efficacy for statistics was related to cognitive engagement. Participants were randomly assigned to either an extraneous cognitive load or non-extraneous cognitive load condition, and three statistical analyses (ANOVA, t-tests, and correlations) were used to analyze the data. The research addressed the following questions:

1. Do different multimedia instructional designs affect learner performance?
    a. Will participants exposed to the pictures and text (PT) condition score significantly lower on a retention test dealing with correlation problems than participants exposed pictures and narration (PN)?
2. Does the manipulation of multimedia instructional designs affect learner motivation?
    a. Will participants exposed to the PT condition experience a significant decrease in self-efficacy for correlation problems from pre-instruction to post-instruction;
    b. Will participants exposed to the PT condition experience a significant increase in state-test anxiety from pre-instruction to post-instruction;
    c. Will participants in the PT condition have significantly lower post-instruction self-efficacy for correlation problems than participants in the PN condition;
    d. Will participants in the PT condition have significantly higher post-instruction test anxiety than participants in the PN condition?
3. Is there a relationship between motivation and performance in the context of multimedia learning?

a. Is there a significant relationship between performance and self-efficacy for correlation problems;
b. Is there a significant relationship between self-efficacy for correlation problems and test anxiety;
c. Is there a significant relationship between test anxiety and performance on a retention test dealing with correlation problems?

CHAPTER TWO

Method

A quantitative research design was selected for this study to examine the following questions:

1. Do different multimedia instructional designs affect learner performance?
    a. Will participants exposed to the pictures and text (PT) condition score significantly lower on a retention test dealing with correlation problems than participants exposed pictures and narration (PN)?
2. Does the manipulation of multimedia instructional designs affect learner motivation?
    a. Will participants exposed to the PT condition experience a significant decrease in self-efficacy for correlation problems from pre-instruction to post-instruction;
    b. Will participants exposed to the PT condition experience a significant increase in state-test anxiety from pre-instruction to post-instruction;
    c. Will participants in the PT condition have significantly lower post-instruction self-efficacy for correlation problems than participants in the PN condition;
    d. Will participants in the PT condition have significantly higher post-instruction test anxiety than participants in the PN condition?
3. Is there a relationship between motivation and performance in the context of multimedia learning?

a. Is there a significant relationship between performance and self-efficacy for correlation problems;
b. Is there a significant relationship between self-efficacy for correlation problems and test anxiety;
c. Is there a significant relationship between test anxiety and performance on a retention test dealing with correlation problems?

The main reason to employ a quantitative research study was to replicate the Mayer and Moreno (1998) research and extend the research to examine whether the motivational constructs of self-efficacy and anxiety are related and effect performance in a cognitive load context. This section contains a detailed description of the participants and design, materials, procedure, and scoring.

Participants and Design.

The participants were 74 students recruited from College of Education courses at a research university in the Southwestern United States. The majority of the participants (57.5%) were elementary or early childhood education majors. The remaining participants majored in subjects ranging from English education to special education. The mean for participants general ACT Score was 24.56 (3.97). Females accounted for 87.9% of the participants while males comprised 12.1% of the participant pool. The age of participants ranged from 18 to 25 years of age with the mean age being 21.12 (1.27) years of age. The average mean number of math courses taken by participants was 2.78.

All participants were screened for previous coursework or knowledge in statistics. The screening process led to the removal of 8 participants and left the 66 participants for assignment into one of two experimental conditions. Thirty participants served in the pictures and words (PW) group and thirty-six participants served in the picture and narration (PN) group. The participants were randomly assigned to one of the two conditions.

Materials.

For each participant, the paper and pencil materials consisted of a participant questionnaire, a performance test, state anxiety scales in computer use and mathematics, and self-efficacy scales for computer use, learning, and mathematics.

The participant questionnaire solicited information regarding the participants' ACT scores, gender, collegiate grade point average, number and type of math courses taken in college and previous knowledge of correlation and related topics to correlation. The researcher assessed participants' correlation knowledge in following manner. The self-assessment asked the participants to rate their knowledge of correlation by placing a circle around either yes or no to the following questions. Have you taken a statistics course? Do you know what a correlation is? If the participant answers yes to the previous questions, then he or she will be prompted on the self-assessment to provide an answer for the following question. If you know what a statistical correlation is, will you please explain what a statistical correlation is in your own words? The list of questions is included in Appendix A.

The performance test contained twenty-seven multiple-choice questions and three correlation problems assessing participants' knowledge learned from one version of the computerized materials. In the multiple choice section (Items 1-27) of the correlation performance test, the participants were required to select a correct answer from one of four possible answers for each question. In items twenty-eight and twenty-nine, participants were given transfer questions that required participants to create a scatterplot, determine strength of the correlation from the constructed scatterplot and whether the correlation was positive or negative. For item 30, participants were required to generate a strong correlation example from real life that was unique from the test or instructional items. Further information about the performance test is in Appendix B.

The state anxiety scales that the researcher used to assess and state-test anxiety were developed by Sieber, O'Neil, and Tobias (1977) and Spielberger et al. (1978), respectively. The computer anxiety scale contained five items. On the computer anxiety scale, the prompting question read, "How do you feel when you use a computer?" Participants rated the five items ("I feel calm". "I feel tense", "I feel at ease", "I feel jittery", and "I feel relaxed") on a 0 (Not at all) to 3 (Very much so) scale with items one, three, and five reversed scored. Siber, O'Neil, and Tobias reported alpha reliabilities ranged from .83 to .93 for the computer anxiety scale. The specific items are located in Appendix C. The Test Anxiety Inventory contained a likert-type scale ranging from 1 (Almost Never) to 4 (Almost Always) and yields three state anxiety scores, and those are "worry", "emotionally", and a combined "state test anxiety" score. Osterhouse (1972) reported that the split-half reliability for the Inventory of Test Anxiety was .92. The test-retest reliabilities over a seven-week period were .68 for emotionally and .72 for worry (Osipow and Krienbring, 1971). The specific items are located in Appendix D.

The self-efficacy scales that were used in the pre and post-assessments were to assess participants' computer use and correlation self-efficacy. The self-efficacy scales ranged from eight to sixteen items, and participants rated the items on a scale from 0 (Cannot do at all) to 100 (Certain can do). The original used a point likert-type scales respectively (Murphy, Coover, and Owen, 1989). I chose to institute a 100-point rating scale for the computer and correlation self-efficacy scales for several reasons. First, Bandura (1995) noted that utilizing a 100-point rating scale for self-efficacy instruments allows for more variation. In addition, a larger rating scale allowed participants to accurately assess their confidence on a scale that has been used in academic grading for decades.

The computer self-efficacy scale contained sixteen items, which included items such as "Adding and deleting information from a data file", "Copying a disk", "Working on a personal computer", and "Getting the software up and running". Murphy, Coover, and Owen (1989) reported an alpha reliability of .97 for the beginning level computer skills scale. The advanced level and mainframe computer skills subscales were omitted due to non-relevant nature of the subscales to the current investigation. The complete computer self-efficacy scale is located in Appendix E. The correlation self-efficacy scale contained seven items that measured a student's confidence to complete correlation problems that parallel what participants learned while using the correlation software and complete the correlation performance test at the conclusion of the experiment. The complete correlation self-efficacy scale is located in Appendix F.

The computerized materials consisted of two computer programs for multimedia presentations on what correlation is and how it applied to the real world. Both programs generated an identical presentation of the correlation lesson. The only difference between the two programs was that one program contained pictures and text on the same screen (PT) and the second program contained pictures with concurrent narration (PN). The author developed the computerized materials using Microsoft PowerPoint.

The experiment took place in a classroom with tables and chairs with no participant being able to look upon another participant's computer screen or other experimental materials. On the tables, there were six PC compatible computers, which included 15-inch monitors and headphones all participants to wear. Those participants assigned to the pictures and narration condition (PN) received all instruction via narration. The participants assigned to the pictures and text (PT) condition only received a final oral message delivered through the headphones that says, "Thank you for viewing the correlation software. Please complete the green covered packet in front of you."

Procedure.

Participants were tested in groups of one to six per session. Each participant was randomly assigned to a treatment group (either PT or PN) and seated at an individual cubicle in front of a computer..

After receiving initial instructions to proceed through the participant at their own pace and to put on headphones, the participants completed the participant questionnaire and the pre-instruction measures (computer anxiety, test anxiety inventory, correlational self-efficacy, and computer self-efficacy scales). Upon the participants completing the self-efficacy scales, the participants pressed the space bar on the computer, and the instructional software orally communicated the importance of learning correlation and real world applications of correlation. The instructional software advised the participants that they may or may not receive any further narration until the end of the instruction.. After pressing the space bar to begin the computerized instruction, the pictures and narration was presented to participants in the PN treatment and the pictures with text was presented to participants in the PT treatment. When the presentation was finished, the computerized instruction narrated instructions to participants to complete the post-instruction packet (computer anxiety scale, test anxiety inventory scale, correlational self-efficacy scale, computer self-efficacy scale, and a performance test) at their own pace. Upon finishing the performance assessment, the participants were instructed in writing to turn over the paper booklet and quietly leave the computer laboratory.

Scoring.

A scorer determined the performance assessment score. A comprehensive performance assessment score was calculated by counting the number of items the participants correctly answered on the performance assessment. One to two points were given to the participant for each question the participant correctly answered. After calculating the participants' raw scores on the correlation performance test and its multiple choice and student-generated answer subscales, the total points from the correlation performance test and its subscales was converted into a percentage score for purposes of data analysis and discussion.

Mayer and Moreno (1998) noted that some instructional effects were stronger for low experienced learners than for high experienced learners. Therefore, I only included low experienced participants in this study. I determined a participant's experience by examining the self-assessment in the demographic questionnaire. If the participant indicated that he or she has had a statistics class, identified he or she knew what a statistical correlation was, and was able to give a definition of a statistical correlation in their own words, then I eliminated that participant from the study. Eight participants were removed due to having prior knowledge of correlation.

Data Analysis Procedures

In this section, I will outline the following. First, I will restate the research question and provide an overview of the data. Second, I will outline what statistical analysis will be used to answer each question.

Question 1: Do different multimedia instructional designs affect learner performance?

Question 1a: Will participants exposed to the pictures and text (PT) condition score significantly lower on a retention test dealing with correlation than participants exposed pictures and narration (PN)? In answering question 4, I will use the cumulative scores that participants earn on the correlation performance test to assess whether there is a significant difference at the .05 level between participants based upon assignment to the pictures and text (PT) or pictures and narration (PN) conditions. I will use an independent samples t-test to examine whether there is a significant mean difference between the two conditions on the correlation performance test and its subscales. In addition, I will use a One-Way Analysis of Covariance to analyze my data in order to control for computer anxiety and computer self-efficacy.

Question 2: Does the manipulation of multimedia instructional designs affect learning performance?

Question 2a: Will participants exposed to the PT condition experience a significant decrease in self-efficacy for correlation problems from pre-instruction to post-instruction? In answering this question, I will use the participants' cumulative score on the pre and post correlation self-efficacy scales to determine whether there is a significant decrease at .05 level using a dependent samples t-test statistical procedure.

Question 2b: Will participants exposed to the PT condition experience a significant increase in state-test anxiety from pre-instruction to post instruction? In answering this question, I will use the participants' cumulative score on the pre and post combined state-test anxiety scales to determine whether there is a significant increase at .05 level using a dependent samples t-test statistical procedure.

Question 2c: Will participants in the PT condition have significantly lower post-instruction self-efficacy for correlation problems than participants in the PN condition? In answering this question, I will use the participants' cumulative scores on the post correlation self-efficacy scale to determine whether there is a significant difference at the .05 level using an independent sample t-test statistical procedure.

Question 2d: Will participants in the PT condition have significantly higher post-instruction test anxiety than participants in the PN condition? In answering this question, I will use the participants' cumulative scores on the state-test anxiety scale to determine whether there is a significant difference at the .05 level using an independent sample t-test statistical procedure.

Question 3: Is there a relationship between motivation and performance in the context of multimedia learning?

Question 3a: Is there a significant relationship between performance and self-efficacy for correlation problems? In answering this question, I will use the cumulative score that participants obtain on the correlation performance test and the cumulative score that participants obtain on the correlation self-efficacy scale. Using the previously described data, I will use a Pearson's correlation procedure to determine whether performance and self-efficacy are significantly related to one another at the .05 level.

Question 3b: Is there a significant relationship between self-efficacy for correlation problems and test anxiety? In answering this question, I will use the cumulative score on the correlation self-efficacy scale and the combined state-test anxiety score on the Inventory of Test Anxiety to perform a Pearson's correlation to determine whether correlation self-efficacy and test anxiety are significantly related to one another at the .05 level.

Question 3c: Is there a significant relationship between test anxiety and performance on a retention test dealing with correlation problems? In answering this question, I will use the combined state-text anxiety score on the Inventory of Test Anxiety and cumulative score on the correlation performance test to perform a Pearson's correlation to determine whether state-text anxiety and performance are significantly negative related to one another at the .05 level.

CHAPTER THREE

Results

I undertook this study to understand what effects different multimedia conditions can have on performance. In addition, I examined what effects different multimedia designs can have on motivation. Since no other research has examined how extraneous cognitive load multimedia conditions may affect learner motivation, it was important to empirically establish whether extraneous cognitive load affects performance and motivation. The broad and specific research questions that guided the current study are:

1. Do different multimedia instructional designs affect learner performance?
    a. Will participants exposed to the pictures and text (PT) condition score significantly lower on a retention test dealing with correlation problems than participants exposed pictures and narration (PN)?
2. Does the manipulation of multimedia instructional designs affect learner motivation?
    a. Will participants exposed to the PT condition experience a significant decrease in self-efficacy for correlation problems from pre-instruction to post-instruction;
    b. Will participants exposed to the PT condition experience a significant increase in state-test anxiety from pre-instruction to post-instruction;
    c. Will participants in the PT condition have significantly lower post-instruction self-efficacy for correlation problems than participants in the PN condition;

d. Will participants in the PT condition have significantly higher post-instruction test anxiety than participants in the PN condition?

3. Is there a relationship between motivation and performance in the context of multimedia learning?

    a. Is there a significant relationship between performance and self-efficacy for correlation problems;

    b. Is there a significant relationship between self-efficacy for correlation problems and test anxiety;

    c. Is there a significant relationship between test anxiety and performance on a retention test dealing with correlation problems?

To examine these issues, data was collected over a one-semester period from four sections of students enrolled in a learning theory and special education survey courses to prepare pre-service teachers. Participants were randomly assigned to the two-multimedia conditions (pictures and words or pictures and narration). Scores of individual items were aggregated into fifteen variables that are listed in the Table 2.

In this chapter, I will present four major sections. First, I will outline the data cleaning procedures used to extract participants that possessed correlation prior knowledge. Second, I will provide descriptive statistics on the demographic and variable data across the two experimental conditions. Third, I will provide detailed analysis of the original eight research questions. In the final section, I will outline emerging questions that arose from the data along with a detailed analysis of the emerging questions.

Table 2

List of Variables Used in Study

Pretest Variables
Computer Anxiety Scale
Test Anxiety Inventory
Test Anxiety Inventory – Worry Subscale
Test Anxiety Inventory – Emotionality Subscale
Computer Self-Efficacy
Correlation Self-Efficacy
Posttest Variables
Computer Anxiety Scale
Test Anxiety Inventory
Test Anxiety Inventory – Worry Subscale
Test Anxiety Inventory – Emotionality Subscale
Computer Self-Efficacy
Correlation Self-Efficacy
Correlation Performance Test Percentage Score
Correlation Performance Test Percentage Score Multiple Choice Subscale
Correlation Performance Test Percentage Score– Student Generated Answers Subscale

Data Cleaning

In this section, I will explain the methods used to control for participants' prior knowledge about correlation. On the demographic survey that every participant received and completed, there were three questions that recorded their exposure to and familiarity with correlation. Those demographic survey items are listed in Table 3.

Table 3

Demographic Survey Questions

Demographic Survey Question	Response	
Have you taken a statistics course	Yes	No
Do you know what a correlation is	Yes	No
If you know what a statistical correlation is, please explain it in your own words what a statistical correlation is in the space below.		

Using the demographic survey items in Table 2, participants were assigned a (1) for a "Yes" response and a (0) for a "No" response on the first two items. If participants provided a definition that demonstrated their prior knowledge of how two variables are somehow related to one another, then participants received a point. If participants provided an incorrect definition or did not complete the item, then the participants received a zero for that response. A new aggregated variable called "statfam" was created from items two and three in Table 2, and participants received scores indicated in Table 4.

Table 4

"Statfam" Categorical Table

Label	Score
No familiarity with correlation	0
Little familiarity with correlation	1
Some familiarity with correlation	2

Two methods were utilized to exclude participants from the data set that demonstrated correlation prior knowledge. Method 1 was the use of item one in Table 3. If participants indicated that they previously enrolled in a statistics course, then those participants were extracted from the data set. Using method 1, three participants were removed from the data set. Method 1 utilized the scores from the "statfam" variable noted in Table 4. If participants received a two, then participants were excluded from the data set. Using method 2, five participants were excluded. In total, the data of eight participants was excluded from the data set and was not used in future analyses.

Descriptives

In this section, I will provide the descriptive statistics for the participants randomly assigned to the two-multimedia conditions. First, I will outline the demographic descriptive statistics. Second, I will outline the pre and post measure descriptive statistics by condition.

The demographic data demonstrated the following trends. The majority of the participants (57.5%) were elementary or early childhood education majors. The remaining participants majored in subjects ranging from English education to special education. The mean for participants general ACT Score was 24.56 (3.97). Females accounted for 87.9% of the participants while males comprised 12.1% of the participant pool. The age of participants ranged from 18 to 25 years of age with the mean age being 21.12 (1.27) years of age. The average mean number of math courses taken by participants was 2.78.

The data from the pre and post measures are discussed below by condition. The means and standard deviations for the pre-measures are listed in Table 5. The means and standard deviations for the post-measures are listed in Table 6.

Table 5

Pre Measure Means and Standard Deviations

Variable Item	Condition	
	Pic-Text	Pic-Narration
Computer Anxiety Test Score	.98 (.66)	1.07 (.70)
Test Anxiety Inventory	1.98 (.61)	2.08 (.55)
Worry Subscale	1.73 (.60)	1.79 (.57)
Emotionality Subscale	2.18 (.70)	2.36 (.59)
Computer Self-Efficacy	87.06 (11.93)	91.54 (7.91)
Correlation Self-Efficacy	44.73 (23.91)	48.38 (26.06)

Table 6

Post Measure Means and Standard Deviations (N = 66)

Variable Item	Condition	
	Pic-Text	Pic-Narration
Computer Anxiety Test Score	1.04 (.71)	1.01 (.67)
Test Anxiety Inventory	1.91 (.64)	2.06 (.63)
Worry Subscale	1.71 (.60)	1.83 (.65)
Emotionality Subscale	2.05 (.74)	2.29 (.71)
Computer Self-Efficacy	90.68 (9.12)	92.14 (7.97)
Correlation Self-Efficacy	83.33 (17.07)	83.72 (14.55)
Correlation Performance Test*	66.07 (13.94)	66.81 (13.20)
Multiple Choice Subscale*	63.70 (15.51)	60.70 (17.45)
Student Generated Answer Subscale*	71.39 (19.54)	80.56 (13.94)

*Scores represent percentage of problems correct

Research Questions

Several research questions guided this research that led to the data collection using six pre-measures and nine post-measures. In this section, I will use the data recorded on the pre and post-measures to analyze the following questions.

Question 1: Do different multimedia instructional designs affect learner performance?

Question 1a: Will participants exposed to the pictures and text condition score significantly lower on a test dealing with correlation than participants exposed to pictures and narration? Three independent-samples *t*-tests were used to assess whether there were mean differences for the correlation performance test score, multiple-choice score, and student-generated score. As a result, I used a Bonferroni adjustment to control for Type I error (.05/3 = .017). The *p* value for statistical significance was .017.

An independent-samples *t*-test was conducted to evaluate the hypothesis that participants exposed to the PT condition will have a significantly lower percentage score on the Correlation Performance Test (CPT) than those exposed to the PN condition. The test was statistically non-significant, t (64) = -.221, p = .826.

A second independent-samples t-test was conducted to evaluate the hypothesis that participants exposed to the PT condition will score significantly lower on the CPT multiple choice subscale than those exposed to the PN condition. The test was statistically non-significant, t (64) = .732, p = .467.

A third independent-samples t-test was conducted to evaluate the hypothesis that participants exposed to the PT condition will score significantly lower on the CPT student generated answer subscale than those exposed to the PN condition. The test was statistically non-significant, t (64) = 2.22, p = .03.

A one-way analysis of covariance (ANCOVA) was conducted as a follow-up analysis to the independent t-test analyses. The independent variable, multimedia condition, included two levels: pictures-and-text and pictures-and-narration. The dependent variable was the participants' percentage score on the correlation performance test and the covariates were computer anxiety (post-measure) and computer self-efficacy (post-measure). The ANCOVA was not statistically significant, F (1, 60) = 0.12, MSE = 19.40, p = .74.

ANCOVA analyses were also conducted using the correlation performance test subscales (multiple choice and student generated answers). The ANCOVA analysis of the multiple-choice subscale was clearly non significant, F (1, 60) = 1.56, MSE = 400.73, p = .22. Although the third ANCOVA analysis of student generated answers was not significant, F (1, 60) = 3.41, MSE = 944.02, p =*.07,* it was much closer to significance than the previous ANCOVA analyses.

Question 2: Does the manipulation of multimedia instructional designs affect learner motivation?

Question 2a: Will participants exposed to the PT condition experience a significant decrease in self-efficacy for correlation problems from pre-instruction to post-instruction? A paired-samples *t*-test was conducted to evaluated whether participants' pre-test correlation self-efficacy was significantly higher compared to their post-instruction correlation self-efficacy score. The results were significant (Pre: $M = 44.73$, $SD = 23.91$; Post: $M = 83.33$, $SD = 17.07$), $t\ (29) = -8.89$, $p =.000$) but the results were counter to the research hypothesis, and the standard effect size index *d*, was 0.10, a small value.

Question 2b: Will participants exposed to the PT condition experience a significant increase in state-test anxiety from pre-instruction to post-instruction? Three paired-samples *t*-tests were conducted to evaluate whether PT condition participants experienced an increase in state-test anxiety, worry, and emotionally from pre-instruction to post-instruction. As a result, I used a Bonferroni adjustment to control for Type I error (.05/3 = .017). The *p* value for statistical significance was .017.

The results indicated that the difference between the mean pre-instruction state-test anxiety score ($M = 1.98$, $SD = .609$) and the mean post-instruction state-test anxiety score was statistically significant ($M = 1.91$, $SD = .640$), $t\ (29) = 2.887$, $p = .007$, but the results were counter to the research hypothesis, and the standard effect size index *d*, was -0.11, a small value.

When the TAI worry and emotionality pre and post instruction scores were analyzed using a paired-samples *t*-test, the following results occurred. The paired-samples *t*-test revealed a non-significant statistical pre-post decrease in the TAI worry subscale (Pre: $M = 1.73$, $SD = .597$; Post: $M = 1.71$, $SD = .648$; $t\,(29) = .571$, $p = .573$. However, a paired-samples *t*-test revealed the opposite findings when examining the TAI emotionality subscale. The results indicated that the mean pre-instruction TAI emotionality score ($M = 2.19$, $SD = .70$) was statistically significant compared to the post-instruction TAI emotionality score ($M = 2.05$, $SD = .74$), $t\,(29) = 4.04$, $p = .000$. The standard effect size index *d*, was 0.20, a modest value.

A follow-up one-way within subjects ANOVA was conducted with the factor being the participants' multimedia condition and the dependent variable being TAI (state-test anxiety) post scores. The means and standard deviations are presented in Tables 5 and 6. The results for the ANOVA indicated a statistically non-significant state-test anxiety effect, $F\,(1, 62) = 1.34$, $MSE = .001$, $p = .25$.

A second follow-up one-way within subjects ANOVA was conducted with the factor being the participants' multimedia condition and the dependent variable being TAI Worry subscale post scores. The means and standard deviations are presented in Tables 5 and 6. The results for the ANOVA indicated a non-significant TAI Worry effect, $F\,(1, 63) = 1.611$, $MSE = .002$ $p = .209$.

A third follow-up one-way within subjects ANOVA was conducted with the factor being the participants' multimedia condition and the dependent variable being TAI Emotionality subscale post scores. The means and standard deviations are presented in Table 6. The results for the ANOVA indicated a statistically non-significant difference in pre to post emotionality subscale scores, $F\,(1, 63) = .741$, $MSE = .002$ $p = .393$.

Question 2c: Will participants exposed to the PT condition have significantly lower post-instruction self-efficacy for correlation problems than participants in the PN condition? An independent-samples *t*-test was conducted to evaluate the hypothesis that participants exposed to the PT condition will score significantly lower on a post-instruction correlation self-efficacy scale than those exposed to the PN condition. The test was statistically non-significant, t (64) = -0.10, p = .92.

Question 2d: Will participants in the PT condition have significantly higher post-instruction state-test anxiety than participants in the PN condition? An independent-samples *t*-test was conducted to evaluate the hypothesis that participants exposed to the PT condition will score significantly higher on a post-instruction test anxiety scale than those exposed to the PN condition. The test was statistically non-significant, t (63) = -0.97, p = .34.

Question 3: Is there a relationship between motivation and performance in the context of multimedia learning?

Question 3a: Is there a significant relationship between performance and self-efficacy for correlation problems? Correlation coefficients were computed among the correlation test, including the multiple choice and student generated answers subscales, and the post correlation self-efficacy measure. The results of the correlational analyses are presented in Table 7 show that 4 out of the 6 correlations were statistically significant and were greater than or equal to .338. The statistically significant correlations demonstrate that as participants performance increased on the correlation performance test and its multiple choice subscale, participants correlation self-efficacy increased.

Table 7

Correlation Performance Test and Self-Efficacy Correlations (N=66)

Subscale	1	2	3	4
1. Correlation Performance Test		.92**	.55**	.34**
2. Correlation Multiple Choice Subscale			.18	.40**
3. Correlation Student Generated Subscale				-.01
4. Correlation Self-Efficacy (Post)				

** Correlation is significant at the 0.01 level (2-tailed).

The correlations of the student generated answer subscale with the multiple choice subscale or the post correlation self-efficacy scores tended to be lower and non significant. In general, the results suggest that if participants achieve a high score on the correlation performance test that they achieved a high score on both the multiple choice and student generated answers subscales as well as a high score on the post correlation self-efficacy measure.

Question 3b: Is there a significant relationship between self-efficacy for correlation problems and test anxiety? Correlation coefficients were computed among the post correlation self-efficacy, post-test anxiety inventory measures as well as the post worry and emotionality subscales of the test anxiety inventory measure. Using the Bonferroni approach to control for Type I error across the 8 correlations, a *p*-value of less than .005 (.05/8 = .00625) was required for significance. The results of the correlational analyses are presented in Table 8 show that 3 out of the 8 correlations were statistically significant and were greater than or equal to .852. The correlations of correlation self-efficacy (post) with the test anxiety inventory, including the worry and emotionality subscales, tended to be lower and non significant. In general, the results suggest that if participants score high on the test anxiety inventory (post) that they achieved a high score on the worry and emotionality TAI subscales.

Table 8

Correlation Self-Efficacy and Anxiety Correlations (N = 66)

Subscale	1	2	3	4
1. Correlation Self-Efficacy (Post)		-.14	-.18	-.12
2. Test Anxiety Inventory (Post)			.95**	.97**
3. TAI Worry Subscale (Post)				.85**
4. TAI Emotionality Subscale (Post)				

** Correlation is significant at the 0.01 level (2-tailed).

Question 3c: Is there a significant relationship between test anxiety and performance on a test dealing with correlation problems? Correlation coefficients were computed among the correlation performance test, including the multiple choice and student generated answers subscales, and the test anxiety inventory (post), including the worry and emotionality subscales. The results of the correlational analyses are presented in Table 9 show that 8 out of the 12 correlations were statistically significant and were greater than or equal to -.545 and less than or equal to -.263. The TAI worry subscale and the CPT student generated answers subscale tended to be lower and non significant.

In general, the results suggest the following. First, when participants score higher on the TAI, they scored higher on the TAI worry and emotionality subscales. Second, when participants scored higher on the TAI, they tended to score lower on the correlation performance test, including the multiple choice and student generated answers subscales. Third, when participants scored higher on the TAI worry subscale, they tended to score lower on the CPT multiple choice and student generated answers subscales. Fourth, when participants scored higher on the TAI emotionality subscale, they tended to score lower on the correlation performance test, including the multiple choice and student generated answers subscales.

Table 9

Test Anxiety and Correlation Performance Test Correlations (N = 66)

Subscale	1	2	3	4	5	6
1. TAI General (Post)	---	.95**	.97**	-.40**	-.34**	-.26*
2. TAI Worry Subscale (Post)		---	.85**	-.37**	-.35**	-.18
3. TAI Emotionality Subscale (Post)			---	-.36**	-.29*	-.27*
4. CPT General (Post)				---	.92**	.55**
5. CPT Multiple Choice Subscale (Post)					---	.18
6. CPT Student Generated Answers Subscale (Post)						---

** Correlation is significant at the 0.01 level (2-tailed)
 * Correlation is significant at the 0.05 level (2 tailed)

Emerging Questions from the Data

Due to the mixture of significant and non-significant findings, it led me to examine the data to see what variables may influence participants' performance on the correlation performance test. Therefore, I examined the mean differences in the demographic data and noticed no striking differences between the groups, and this was verified by a non-significant finding using an independent-samples t-test. However, I wondered whether the demographic data were related to participants' performance on the correlation performance test. These thoughts lead me to examine the data by using the subsequent question.

Follow-Up Question 1: What unexplored variables correlate with participants' scores on the correlation performance test? Correlation coefficients were computed among the correlation test, including the multiple choice and student generated answers subscales, self-reported collegiate grade point average, self-reported ACT score, and number of math courses taken. The results of the correlational analyses are presented in Table 9 show that 11 out of the 15 correlations were statistically significant and were greater than or equal to .335 and less than or equal to -.334. The correlations of CPT student generated answers subscale (post) with self-reported collegiate grade point average, self-reported ACT Score, and CPT multiple-choice subscale (post) tended to be lower and not statistically significant.

There are several statistically significant correlations. Self-reported collegiate grade point average was positively correlated with the correlation performance test and its multiple-choice subscale. This meant as participants collegiate grade point average increased that their correlation performance test and the multiple-choice subscale scores also increased.

Table 10

Demographic Data and Correlation Performance Test Correlations (N = 66)

Subscale	1	2	3	4	5	6
1. Self-reported Collegiate GPA	---	.39**	- .20	.34**	.38**	.03
2. Self-reported ACT Score		---	-.51**	.52**	.54**	.12
3. Number of Math Courses Taken			---	-.46**	-.39**	-.33**
4. CPT General (Post)				---	.92**	.55**
5. CPT Multiple Choice Subscale (Post)					---	.18
6. CPT Student Generated Answers Subscale (Post)						---

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2 tailed)

The self-reported ACT Score was also positively correlated with the correlation performance test and its multiple-choice subscale. This meant as participants self-reported ACT score increased that the correlation performance test and the multiple-choice subscale scores increased. Number of math courses taken was negatively correlated with all aspects of the correlation performance test, which means as the participants number of math class taken increased scores on the correlation performance test and its subscales significantly decreased.

CHAPTER FOUR

Discussion

My initial interest for the current investigation focused around three broad areas of inquiry, and those are:

1.) Do different multimedia instructional designs affect learner performance?

2.) Does the manipulation of multimedia instructional designs affect learner motivation?

3.) Is there a relationship between motivation and performance in the context of multimedia learning?

These broad questions led me to develop eight specific research questions. Those questions are listed in Chapter 1, methodologically addressed in Chapter 2, and answered in Chapter 3.

The literature review established the rationale to examine the previously noted broad questions in the following manner. First, this study attempted to replicate the Mayer and Moreno (1998) findings, which is a foundation of the scientific method. Second, this study attempted to extend the Mayer and Moreno findings to examine how motivation is related to and can affect learner performance. Third, this study attempted to examine the influence of multimedia instructional designs upon motivation and performance and provides a research template for further investigation of how different multimedia instructional designs may affect learner motivation and performance.

This discussion chapter is organized around three specific items. First, I will discuss the research findings. Second, I will discuss the limitations of the current study. Third, I will discuss the future directions of research based upon the current research.

Research Findings.

First Broad Question

Do different multimedia instructional designs affect learner performance?

There were mixed findings that arose out of question 1. When I examined performance by condition, I discovered non-significant differences in participants' performance on the correlation performance test and its multiple choice subscale. My findings contradict what Mayer and Moreno (1998) who found statistical significant differences in retention, recall, and transfer test scores between multimedia conditions. However, there were several differences between the Mayer and Moreno studies and my study.

The first was a design difference. In the Mayer and Moreno (1998) study, participants across both multimedia conditions had a limited amount of time to view each screen, whereas there was an unlimited amount of time in my study. In addition, the PT participants had an unlimited time to study the screen and make referential connections between the pictures and the text, whereas the PN participants only had one opportunity to listen to the narration. The PN participants were not given the mechanism to replay the narration. Thus, the software design may have unintentionally served to suppress PN participants' scores on the correlation performance test and the multiple-choice subscale. As a consequence, this may have led to non-significant differences between the two conditions as related to the correlation performance test and the multiple choice subscale.

The second way in which my study differed was in content domain. In the Mayer and Moreno (1998) and Mousavi, Low, & Sweller (1995) studies, the domains were the study of lightning and how to do electronic wiring, whereas the domain used in my study was learning correlation. The differences in the domains used may have led to intrinsic cognitive load differences between the content areas. The domains used in the Mayer & Moreno and Mousavi, Low, & Sweller studies were scientific and technical domains. The scientific and technical domains have greater intrinsic cognitive load due to the numerous events that lead to lighting or the numerous procedural steps learners needed to master electronic wiring. On the other hand, the correlation domain may not have had the complexity or numerous steps needed to have high intrinsic cognitive load as compared to the other domains, but there is no index to measure domain differences between cognitive load studies. Therefore, it is impossible to determine whether the domain used in the current study contributed to statistically non-significant findings.

Second Broad Question

Does the manipulation of multimedia instructional designs affect learner motivation?

In question 2a, I examined whether participants exposed to the PT condition would experience a decrease in self-efficacy for correlation problems from pre-instruction to post-instruction. In question 2b, I examined whether participants exposed to the PT condition would experience an increase in state-test anxiety from pre-instruction to post-instruction. The results indicated the opposite of my research hypotheses for questions 2a and 2b. In question 2c, I examined whether participants exposed to the PT condition would experience lower post-instruction self-efficacy for correlation problems than participants in the PN condition. The PT and PN participants experienced no correlational self-efficacy differences. In question 2d, I examined whether participants in the PT condition would experience higher post-instruction state-test anxiety than participants in the PN condition. The PT and PN participants experienced no post-instruction state-test anxiety differences. The finding is counter to my research hypothesis, but the result is not necessarily surprising given the design and domain issues that were previously discussed.

However, there is a possible explanation for the non-significant findings beyond the design and domain issues, and that is related to learner pace and referential connections. In this study, participants were able to control the pace of instruction. As a consequence, the participants, especially those exposed to the PT condition, were able to make referential connections between the pictures and the text. In turn, the PT participants did not have any concerns about "missing" any instruction, which may have caused a decrease of anxiety related to the task and a corresponding increase in correlational self-efficacy. The explanation corresponds with Bandura's (1998) theoretical claim about the relationship of anxiety and self-efficacy.

Third Broad Question

Is there a relationship between motivation and performance in the context of multimedia learning?

In question 3a, I examined whether there was a significant relationship between correlational self-efficacy and performance on correlation test. The results indicated that there was a significant positive relationship between the participants' correlation self-efficacy and scores on the correlation performance test. This finding is consistent with the research examining the relationship between self-efficacy and performance (Boyce & Bingham, 1997; Elias & Loomis, 2002; Jackson, 2002; Pintrich & DeGroot, 1990;

Thompson, Meriac, & Cope, 2002) along with Bandura's claim (1997) that self-efficacy has a causal effect upon performance.

In question 3b, I examined whether there was a significant relationship between self-efficacy for correlation problems and test anxiety. The results indicated that there was a non-significant negative relationship between correlation self-efficacy and test anxiety, and this is not consistent with the previous research examining the research between self-efficacy and anxiety (Blair, O'Neil, & Price, 1999; Ender et al, 2001; Malpass, O'Neil, & Hocevar, 1999; Pajares & Graham, 1999; Pajares & Valiente, 2001). The direction was fine; however, the small variation of the TAI scale may have contributed to the non-significant negative relationship between self-efficacy and anxiety.

In question 3c, I examined whether there was a significant relationship between test anxiety and performance on a test dealing with correlation problems. The correlational analysis revealed a significant negative correlation between test anxiety and performance on the correlation performance test. As participants became more anxious about their performance on the test, the participants' scores decreased. The results are consistent with the theoretical claim and empirical research that suggests that higher levels of anxiety leave less working memory resources available for task processing, and as a result, that leads to impaired performance (Eysenck, 1992; Borkowski & Mann, 1968; Darke, 1988a; Darke; 1988b).

Summary and Future Directions

This study yielded a mixture of significant and non-significant findings regarding the effect of extraneous cognitive load upon motivation and performance. The mixture of results does not mean that there is empirical evidence to reject the notion that high extraneous cognitive load multimedia conditions affect motivation and performance. The results suggest two things. First, the correlation instruction significantly increased participants self-efficacy for correlation. Second, there were confounds such as processing time and domain differences that affected the results. This suggests that my study cannot definitively answer whether extraneous cognitive load conditions adversely impact motivation and performance. Therefore, further research is needed to examine these issues.

The current study served to provide information that led to the development of a rough blue print for future research. A carpenter needs a detailed print to build a house, and a carpenter often alters the blueprint to make a home better. I plan to use this research as a blue print to modify the current research to empirically measure differences in motivation and performance based upon exposure to various high extraneous cognitive load multimedia conditions. Specifically, I plan to modify the current study by controlling the pace of instruction, using a domain that is further removed from participants' common academic knowledge, and having a larger sample size. These modifications to the current study should provide a better test of the hypothesis that extraneous cognitive load affects motivation and performance.

If the modified research design provides significant results, I plan to use the modified research design as a template to examine other extraneous cognitive load multimedia conditions and how those extraneous cognitive load conditions effect motivation and performance. One future study could include examining whether large bites of presented information impacts motivation and performance as compared to small bites of presented information in multimedia learning environments. Another study can examine whether physically integrated animation and text is significantly better than separated animation and text and whether there is a significant difference in anxiety and self-efficacy between the two conditions. Also, I plan to examine whether learner controlled pace of multimedia learning can mitigate the effects of extraneous cognitive load conditions.

Although the current cognitive load literature provides a wealth of information regarding how extraneous cognitive load can negatively impact performance, the results were yielded in artificially induced learning environments. Normally, learning does not occur in artificially induced environments, and as a result, it limits the generality of the research findings. Therefore, the field needs to assess how extraneous cognitive load impacts learning in authentic learning environments, such as classroom or workplace training settings.

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Appendix A:

Participant Questionnaire

Demographic Questionnaire

1. Gender (Please circle one): Male Female

2. Age: ______________________________

3. Academic Major: ______________________________

4. Collegiate GPA: ______________________________

5. ACT Score: ______________________________

6. ACT Math Score: ______________________________

7. Number of Math Course
Taken in College (please circle one): 0 1 2 3 4 5

8. What specific math courses
have you taken in college:

____

____

____

____

9. Have you taken a statistics course? Yes No

10. Do you know what a correlation is? Yes No

11. If you know what a statistical correlation is,
please explain in your own words what a statistical
correlation is in the space below.

Appendix B:

Performance Test

Retention and Transfer Test from Pearson Correlation Computer Module

Directions: **For each question, please indicate your answer by circling the statement graph or providing a written answer in the space provided.**

1.) A graphical technique used to examine the data collected in correlational research is ____________________.

a. box-and-whisker
b. bar graph
c. line graph
d. scatterplot
e. dot-chart

2.) Which of the following is a true statement?

a. r = .24 is higher than r = 0.00
b. r = .86 is higher than r = .92
c. r = .86 is lower than r = .45
d. r = .64 is lower than r = .58
e. r = .52 is lower than r = .46

3.) When the relative position of each X value is equal to the relative position of its corresponding Y value, the correlation will be _________.

a. 1.00
b. -1.00
c. 0.00
d. greater than 0 and less than 1.00
e. less than 0 and greater than -1.00

4.) It is possible to compute a coefficient of correlation if one is given:

a. a single score
b. two sets of measurements on the same individuals
c. 50 scores of a clerical aptitude test
d. single measures of each subject's behavior
e. data that conform to a clearly defined model

5.) Which of the following statements concerning Pearson r is false?

a. r = 0.00 represents the absence of a relationship
b. the relationship between two variables must be nonlinear
c. r = .76 has the same predictive power as r = -.76
d. r = 1.00 represents a perfect relationship
e. the larger the absolute values of r the greater the relationship

6.) When the relationship between two variables is curvilinear, the Pearson *r* will be:

a. 0.00
b. negative
c. positive
d. some value between -.50 and -.20
e. Pearson *r* will not be appropriate

7.) The Pearson product-moment correlation correlation coefficient is a measure of the

a. magnitude of the relationship between X and Y.
b. linearity of the relationship between X and Y.
c. magnitude and direction of the linear relationship between X and Y
d. relationship between two groups of persons on a variable.

8.) If all the points of a scatterplot fall on a diagonal line, then r is:

a. positive.
b. negative.
c. zero.
d. perfect.
e. curvilinear.

9.) Which one of the following correlation coefficients indicates the strongest linear relationship between variables X and Y?

a. .0
b. -.70
c. .1
d. .60
e. .099

10.) The correlation coefficient obtained from a single pair of measurements is:

a. 0.00
b. .50
c. 1.00
d. -1.00
e. impossible to calculate

11.) Which of the following is a true statement?

a.) r = .24 represents a larger correlation between X and Y than r = .36
b.) r = -.81 represents a larger correlation between X and Y than r = .75
c.) r = -.38 represents a larger correlation between X and Y than r = .75
d.) r = .43 represents a larger correlation between X and Y than r = -.67
e.) all the above are false

12.) A scatterplot in the shape of a crescent indicated that r is:

a.) positive.
b.) negative.
c.) zero.
d.) perfect.
e.) curvilinear.

13.) The scatterplot of a strong positive correlation between two variables would appear as a swarm of points

a.) oriented from lower-left to the upper-right of the chart.
b.) oriented from lower-right to the upper-left of the chart.
c.) rather circular in appearance with no discernable orientation.
d.) oriented horizontally from left to right near the top of the chart.

14.) Most of the pupils who scored below the mean on test 1 also scored below average on test 2; the correlation between the two tests appears to be

a.) positive.
b.) negative.
c.) near zero.
d.) curvilinear.
e.) 1.0

15.) Which value of r appears most reasonable given these following 5 pairs of scores: (20, 40), (30, 30), (40, 20), (50, 10), (60, 0)?

a.) -1.0
b.) .00
c.) .50
d.) 1.0
e.) -.50

16.) After several studies, Professor Smith concludes that there is a zero correlation between body weight and bad tempers. That means that:

a.) heavy people tend to have bad tempers
b.) skinny people tend to have bad tempers
c.) no one has a bad temper
d.) everyone has a bad temper
e.) a person with a bad temper may be heavy or skinny

17.) A well-paid statistician reports that the correlation between college entrance exam grades and scholastic achievement was found to be -1.08. On the basis of this, you would tell the university that:

a.) the entrance exam is a good predictor of success
b.) they should hire a new statistician
c.) the exam is a good test
d.) students who do best on this exam will make the worst students
e.) students at this school are underachieving

18.) If adults scoring high on a scale of assertiveness were also expected to score high on a self-confidence criterion

a.) a positive relationship between the variables must exist
b.) The Spearman *r* must be close to zero
c.) both measures must be related according to a rank-order scale
d.) the variables must be perfectly correlated
e.) none of the above

19.) Kay examined the relation between the amount of exercise and body fat. She found that people who exercise much have a low proportion of body fat whereas those who exercise little have a high proportion of body fat. Kay has provided evidence of ____________.

a.) a positive correlation
b.) a negative correlation
c.) a cause and effect relation between exercise and fat
d.) no meaningful relation between exercise and fat
e.) these data cannot be interpreted

20.) Mark studies personality. He predicts that people who are more extroverted will be more likely to participate in risk taking sports such as rock climbing and sky diving. Mark is suggesting that _____________.

a.) there is a positive correlation between personality and behavior
b.) there is a negative correlation between personality and behavior
c.) a cause and effect relation between personality and behavior
d.) there is no meaningful relation between personality and behavior
e.) these data cannot be interpreted

21.) Two researchers examined the testosterone levels of men in prison. They found that prisoners who committed more serious crimes (battery, armed assault, murder, rape) had higher levels of testosterone than prisoners who committed less serious crimes. These data are evidence ___________.

a.) for a positive correlation between testosterone levels and criminal behavior
b.) for a negative correlation between testosterone levels and criminal behavior
c.) a cause and effect relation between testosterone levels and criminal behavior
d.) no meaningful relation between testosterone levels and criminal behavior
e.) these data cannot be interpreted

22.) Researchers in the Department of Public Transportation examined the effects of alcohol on the time it takes to respond to a signal. Their data revealed that subjects who drank more alcohol took longer to respond to signals than subjects who drank no alcohol. These data are evidence _________.

a.) for a positive correlation between alcohol consumption and reaction time
b.) for a negative correlation between alcohol consumption and reaction time
c.) a cause and effect relation between alcohol consumption and reaction time
d.) no meaningful relation between alcohol consumption and reaction time
e.) these data cannot be interpreted

23.) A psychologist states that using the PDQ test of personality he can accurately predict a person's behavior. Therefore, we can conclude that in this case _________.

a.) personality causes people to behave the way they do
b.) the relation between personality and behavior is due to chance
c.) test scores on the PDQ test and behavior are correlated
d.) personality and behavior are independent of one another
e.) none of the above are true

24.) A team of biologists and psychologists found a strong correlation between levels of testosterone and criminal behavior. Men with higher levels of testosterone are more likely to commit criminal behavior than men with lower testosterone levels. Using these data we can conclude that ______________.

a.) testosterone and criminal behavior are somehow related to each other
b.) testosterone causes men to be more violent than women
c.) testosterone causes men to be violent
d.) increases in testosterone causes people to be more likely to be criminals
e.) none of the above are true

The following three questions refer to the following problem:

A study of 75 business executives evaluated the salary, religious affiliation, amount of physical exercise, and health condition of each executive. The correlation coefficient between salary and religious affiliation was 0.35, whereas the correlation coefficient between the amount of exercise and health condition was 0.70. The correlation between salary and the amount of physical exercise was 0.55.

25.) Which of the following statement would be incorrect based on the preceding information?

a.) The correlation between salary and exercise is better than the correlation between salary and religion.
b.) The information indicates the higher paid executives get less physical exercise.
c.) Religious affiliation is strongly correlated with geographical location.
d.) More exercise is good for the executives' health.
e.) None of the above is true.

26.) Between which of the two variables given above is the highest degree of relationship indicated?

a.) salary and religion
b.) exercise and salary
c.) exercise and health
d.) health and religion
e.) sex and salary

27.) A scatterplot of salary versus the amount of exercise would

a.) cluster around a diagonal line drawn from the lower left to the upper right of the graph
b.) cluster about the origin
c.) be bimodal
d.) cluster about a diagonal line drawn from the upper left to the lower right of the graph
e.) none of the above

28.) Using the variables below, please create a scatterplot below and plot the variables and explain how strong the correlation is and whether it is positive or negative.

The variables are men's weight and age.

	Weight	Age
Person 1	220 lbs	45 years old
Person 2	175 lbs	30 years old
Person 3	155 lbs	78 years old
Person 4	260 lbs	60 years old
Person 5	177 lbs	28 years old
Person 6	166 lbs	22 years old

A.) Create a scatterplot.

B.) How strong is this correlation?

C.) Is this correlation positive or negative?

29.) Using the variables below, please create a scatterplot below and plot the variables and explain how strong the correlation is and whether it is positive or negative.

The variables are individuals' grade point averages and exercise activity in hours.

	GPA	Exercise Activity (hours) per week
Person 1	3.4	3
Person 2	1.9	9
Person 3	2.4	6
Person 4	4.0	8
Person 5	1.7	10
Person 6	2.7	5
Person 7	2.9	4
Person 8	3.9	1
Person 9	2.0	8
Person 10	3.2	3

A.) Create a scatterplot.

B.) How strong is this correlation?

C.) Is this correlation positive or negative?

30.) Given the space below, please describe an example of a strong correlation in real life that is unique from test or instructional items.

You have completed all the instruments for this study. Please leave the packet on the desk and exit the classroom quietly. Thank you for participating in this study.

Appendix C:

Computer Anxiety Scale

Directions: **For each item, please use a "x" or place a check mark in the box that most accurately reflects your answer to the question below**

How do you feel when you use a computer?

	0	**1**	**2**	**3**
Items	**Not at all**	**Somewhat**	**Moderately so**	**Very Much so**
I feel calm				
I feel tense				
I feel at ease				
I feel jittery				
I feel relaxed				

Appendix D:

Test Anxiety Inventory

Directions: **For each item, please use a "x" or place a check mark in the box that corresponds with your feeling regarding each statement concerning tests.**

Item	Almost Never (1)	Sometimes (2)	Often (3)	Almost Always (4)
I feel confident and relaxed during tests*				
I feel uneasy and upset during finals				
Thinking about my grade interferes with work				
I freeze up on finals				
Thinking about whether I'll get through school				
I get confused when working on tests				
Thoughts of doing poorly interfere with my concentration				
I feel jittery during tests				
I feel anxious during tests, even when well prepared				
I'm uneasy before getting test paper back				
I feel tense during tests				
I wish exams did not bother me so much				
I feel so tense my stomach gets upset during tests				
I defeat myself on tests				
I feel panicky during tests				
I worry before important tests				
I'm thinking of failing during tests				
My heart beats fast during tests				
I worry after the exam is over				
I am nervous and forget facts during exams				

Appendix E:

Computer Self-Efficacy

Directions: **Using the scale below, please write a number down that most closely corresponds with your confidence of being able to do each computer task listed below.**

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					***Moderately certain can do***					***Certain can do***

Questions	Score (0-100)
1. Adding and deleting information from a data file	____________
2. Escaping/Exiting from the program/software	____________
3. Copying an individual file	____________
4. Copying a disk	____________
5. Making selections from an onscreen menu	____________
6. Moving the cursor around the monitor screen	____________
7. Using a printer to make a "hardcopy" of my work	____________
8. Using a computer to write a letter or essay	____________
9. Handling a floppy disk correctly	____________
10. Entering and saving data (numbers or words) into a file	____________
11. Storing software correctly	____________
12. Getting rid of files when they are no longer needed	____________
13. Working on a personal computer	____________
14. Getting the software up and running	____________
15. Calling up a data file to view on the monitor screen	____________
16. Organizing and managing files	____________

Appendix F:

Correlation Self-Efficacy

Directions: Using the scale below, please write a number down that most closely corresponds with your confidence of being able to do each task listed below.

0	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*100*
Cannot do at all					***Moderately certain can do***					***Certain can do***

Questions Scale (0-100)

1. I am sure I could identify the correct correlation definition. ___________

2. Given a description of a scatterplot, I am sure I could distinguish whether it was linear or non-linear ___________

3. Given a description of a scatterplot, I am sure I could distinguish whether the scatterplot was positive or negative ___________

4. Given several pairs of data, I am sure I could identify whether the data represented a positive or negative correlation ___________

5. Given several correlation coefficients, I am sure I could identify which correlation coefficient was the strongest. ___________

6. Given a verbal description of two variables and their relationship, I am sure I could identify the example as a positive or negative correlation. ___________

7. If asked, I am sure I could give an example of a strong correlation in real life. ___________

8. Given a correlation problem, I am sure I could create a graph, plot the variables, and explain what is occurring with the variables. ___________

Appendix G:

IRB Consent Letters

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

January 31, 2005

Mr. William R. Christensen II
Educational Psychology
Carpenter Hall, Room 111
CAMPUS MAIL

RE: Exempt from IRB Review
IRB Number: FY2005-222
Title: The effects of cognitive load conditions upon performance, anxiety, and self-efficacy in computer-based learning environments

Dear Mr. Christensen II:

The Institutional Review Board considers that this research is exempt in accordance with the Code of Federal Regulations, Title 45, Part 46, Sub-part 101 (b), Category:

> 2 *Research using cognitive, diagnostic, aptitude, and educational achievement tests, or surveys, interviews, or observations of public behavior, unless human subjects are identifiable, and disclosure of responses could put them at risk of liability, or damage to their reputations or financial standing*

as revised November 13, 2001 Further review of this study by the IRB is not required unless the protocol changes with regards to the use of human subjects In that case, the study must be resubmitted immediately to the Board Please inform the IRB when this research is completed

If you have any questions related to this research or the IRB, you may telephone the IRB staff at 405 325 8110 or visit our web site out irb@ou.edu

Cordially,

E. Laurette Taylor, Ph.D.
Chair
Institutional Review Board – Norman Campus (FWA #00003191)

FY2005-52

cc: Prof. Raymond Miller, Educational Psychology

660 Parrington Oval, Suite 316, Norman, Oklahoma 73019-3085 PHONE: (405) 325-8110 FAX: (405) 325-2373

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

February 25, 2005

Mr William R Christensen II
Educational Psychology
ECH 111
CAMPUS MAIL

SUBJECT: "The effects of cognitive load conditions upon performance, anxiety, and self-efficacy in computer-based learning environments"

Dear Mr Christensen II:

The Institutional Review Board has reviewed and approved the requested revision to the subject protocol.

Please note that this approval is for the protocol and informed consent form initially approved by the Board on January 31, 2005, and the revision included in your request dated February 22, 2005 to the following:

- **Addition of classes EDSP 3054 and EIPT 3483 as study sites**

If you wish to make other changes, you will need to submit a request for revision to this office for review

If you have any questions, please contact me at 325-8110.

Cordially,

E. Laurette Taylor

E. Laurette Taylor, Ph D
Chair
Institutional Review Board - Norman Campus (FWA #00003191)

FY2005-52

cc: Prof Raymond Miller, Educational Psychology

660 Parrington Oval, Suite 316 Norman Oklahoma 73019-3085 PHONE: (405) 325-8110 FAX: (405) 325-2373

The University of Oklahoma

OFFICE FOR HUMAN RESEARCH PARTICIPANT PROTECTION

March 11, 2005

Mr. William R. Christensen II
Educational Psychology
Carpenter Hall, Room 111
CAMPUS MAIL

SUBJECT: "The effects of cognitive load conditions upon performance, anxiety, and self-efficacy in computer-based learning environments"

Dear Mr. Christensen II:

The Institutional Review Board has reviewed and approved the requested revision to the subject protocol.

Please note that this approval is for the protocol and informed consent form initially approved by the Board on October 7, 2004, and the revision included in your request dated March 1, 2005 to the following:

- **Revisions to the survey instrument**

If you wish to make other changes, you will need to submit a request for revision to this office for review.

If you have any questions, please contact me at 325-8110.

Cordially,

E. Laurette Taylor, Ph.D.
Chair
Institutional Review Board - Norman Campus (FWA #00003191)

FY2005-52

cc: Prof. Raymond Miller, Educational Psychology

660 Parrington Oval, Suite 316 Norman Oklahoma 73019-3085 PHONE: (405) 325-8110 FAX: (405) 325-2373

Appendix H:

Permission Letter to Use of Test Anxiety Inventory

USF
UNIVERSITY OF
SOUTH FLORIDA

February 4, 2005

William R. "Rob" Christensen II
Zarrow Center for Learning Enrichment
840 Asp Avenue, Room 111
University of Oklahoma
Norman, OK 73019

Dear Mr. Christensen:

In response to your recent request, I am very pleased to give you permission to reproduce the Test Anxiety Inventory (TAI) for your dissertation research (and associated work) entitled:

Cognitive Load, Self-Efficacy and Anxiety: The Effects on Performance

It is my understanding that your research will be carried out at:

University of Oklahoma
Norman Campus

This permission is contingent on your agreement to share your research findings with us. I look forward to receiving further details about your procedures and the results of your study as such information becomes available

Best wishes on your research project

Sincerely,

CD Spielberger

Charles D. Spielberger, Ph.D., ABPP
Distinguished Research Professor of Psychology
Director, Center for Research in Behavioral
Medicine and Health Psychology
Phone (813) 974-2342; Fax (813) 974-4617

CENTER FOR RESEARCH IN BEHAVIORAL MEDICINE AND HEALTH PSYCHOLOGY
Department of Psychology • University of South Florida • 4202 East Fowler Avenue, PCD4118G, Tampa, Florida 33620-7200
(813) 974-2342 • FAX (813) 974-4617

Appendix I:

Screen Captures of Correlation Software

Learning Correlation

Please hit the spacebar to begin the Learning Correlation presentation

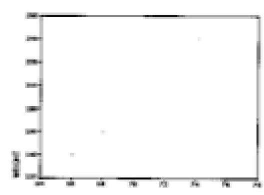
Learning Correlation

Although you may not think knowing correlation is important, it is used in a wide array of fields For example, correlation is used in business, education, psychology and other fields to show relationships between variables

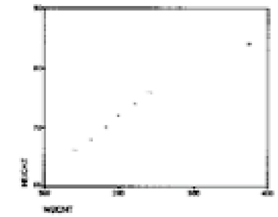
Please hit the space bar on the keyboard to continue

After you hit the space bar to move forward, you may or may not hear any narration coming through the headphones until the end of the correlation program

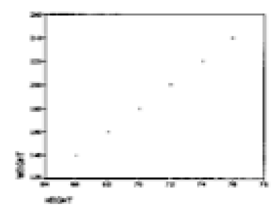
Please hit the space bar to continue



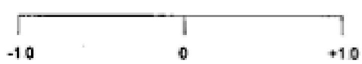
A correlation measures the degree of linear relationship between two variables In the graph above, there is some sort of linear relationship between height and weight.



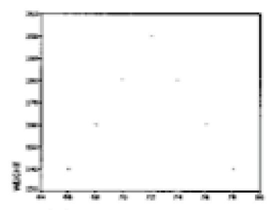
A scatterplot is nothing more than a graphical representation of the relationship between two variables representing the scores in two distributions



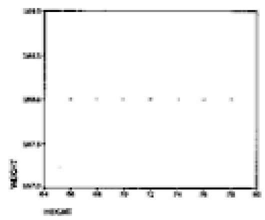
A scatterplot shows the two scores of subjects on one variable plotted against their scores on a second variable with each point representing the data from one subject In the example above you can observe how an individual's height and weight are paired and plotted



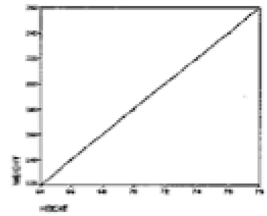
The main result of a correlation is called the correlation coefficient or "r" It ranges from -1 0 to +1 0 The closer r is to -1 0 or +1 0 the more closely the two variables are related



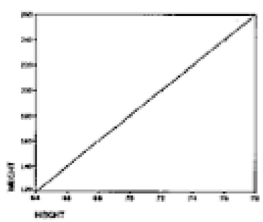
If r is close to 0, it means there is no relationship between the two variables In the case above, there is no relationship between height and weight because the relationship is not linear



Although a linear relationship appears, all the y's in this given set are identical, then r is undefined. If r is undefined, r is 0, which means there is no identifiable relationship between the two variables.

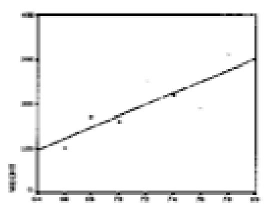


If r is close to or is +1 0, then r represents a strong positive relationship between the two variables. If r is positive, it means that as one variable gets larger the other variable gets larger. In the graph above, height increased as weight increased



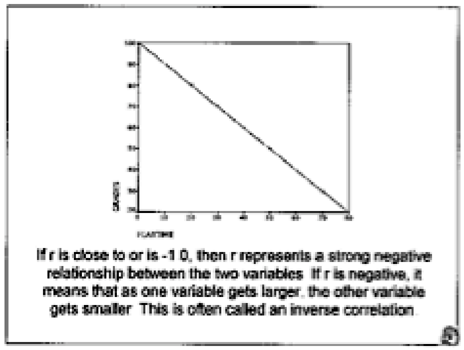
r = + 1 0

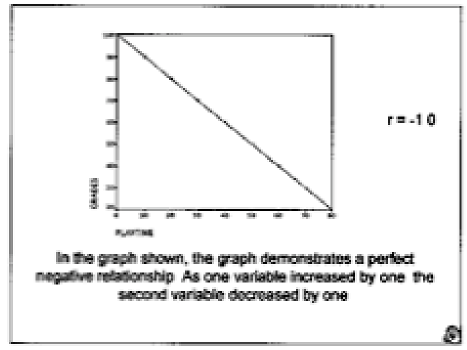
In the shown graph, it demonstrates a perfect relationship. As one variable increased by one unit the second variable increased by one unit

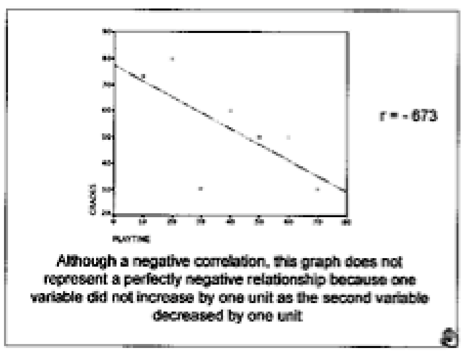


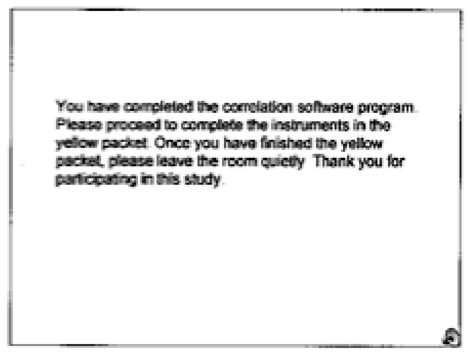
r = + 0 830

Although a positive correlation, this graph does not represent a perfectly positive relationship because the two variables do not increase on a one to one ratio


If r is close to or is -1 0, then r represents a strong negative relationship between the two variables If r is negative, it means that as one variable gets larger, the other variable gets smaller This is often called an inverse correlation


r = -1 0
In the graph shown, the graph demonstrates a perfect negative relationship As one variable increased by one the second variable decreased by one


r = -.673
Although a negative correlation, this graph does not represent a perfectly negative relationship because one variable did not increase by one unit as the second variable decreased by one unit


You have completed the correlation software program. Please proceed to complete the instruments in the yellow packet. Once you have finished the yellow packet, please leave the room quietly Thank you for participating in this study.